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ABSTRACT

Comparisons were made between the use of microfiche materials and conventional printed materials for individualized instruction in two short military courses on aviation and ground maintenance. One group of students in each course used printed instructional materials and microfiche for course achievement tests, while another group used microfiche for instructional materials and tests. In both courses a control group used printed materials and tests exclusively. There were no test score differences among any of the three groups in each course; however, while results indicated that microfiche materials had an initial adverse effect on training time in the first course, this effect decreased rapidly in the second course. Before commitments are made to an extensive use of microfiche materials, it is recommended that their long-term effects be evaluated in a study with sufficient power to assure potential users that real differences in training time as large as those found in this study do not exist. Appendices include a list of course modules, sample learning guides, tables showing cell means for interactions and correlations between attitude and training time, and two student attitude questionnaires with results. (Author/CHV)

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MICROFICHE AND PRINTED MATERIALS IN INDIVIDUALIZED INSTRUCTION: A COMPARISON

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Comparisons were made between microfiche materials and conventional printed materials in two short military courses taught by means of individualized instruction. Students took the courses in sequence. In one set of comparisons, microfiche was used only for the tests; in the other, it was used for both instructional materials and tests. In both sets, control groups used printed materials exclusively. In the first course, students who used microfiche for tests required 18 percent more study time than did the control

students. Those who used microfiche for both instructional materials and tests required 26 percent more time. In the second course the students who used microfiche for tests required 11 percent more time, and those who used it for both instructional materials and tests required 10 percent more time. Neither of the latter differences was reliable. There were no reliable differences in test scores.

FOREWORD

This advanced development was conducted with the sponsorship of the Chief of Naval Technical Training under 6370N 43-03X.P13B: Integrated System for Job-Specific Training and Assignment.

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DONALD F. PARKER
Commanding Officer

SUMMARY

Problem

Most of the individualized training systems in use by the military today require the production and storage of massive amounts of printed material. If these materials were reproduced on microfiche, the logistic problems could be lessened considerably. Before turning to this solution, however, precise information is needed concerning the effects of intensive, long-term use of microfiche materials on the efficiency of student learning.

Objective

The purpose of this investigation was to compare the effectiveness of printed materials and microfiche materials in a fairly typical military training sequence.

Approach

The study was done in the Aviation Familiarization Course, Class P (AFAM) and the Aviation Mechanical Fundamentals Course, Class P (AMFU). The two courses ran sequentially and required, on the average, a little over 1 week of training. One experimental group used printed booklets for instructional materials and microfiche for tests; another used microfiche for both instructional materials and tests. Each experimental group had its own concurrent control group, which used printed booklets for both instructional materials and tests. The effects of using microfiche on time, errors, and attitude toward the courses were tested by a series of treatment-by-level analyses of variance.

Findings

The use of microfiche materials led to reliable increases in training time for the AFAM course. Students who used microfiche for tests required 18 percent more time than did control students, and students who used microfiche for both tests and instructional materials required 26 percent more time than did control students. In the AMFU course, however, the differences were only 11 percent and 10 percent respectively; neither difference was statistically reliable. In no case was there a reliable difference in test scores.

Conclusions

The results seem to indicate that microfiche materials have an initial, adverse effect on training time, but that this effect decreases rapidly with continued use.

The differences found in the second course were not reliable, but real differences of this size would have a major impact on the cost of training.

Recommendations

Before commitments are made to an extensive use of microfiche materials, it would be advisable to evaluate their long-term effects in a study with sufficient power to assure potential users that real differences in training time as large as the differences found in this evaluation do not exist.

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INTRODUCTION

Problem

Increases in the number of individualized training systems have been accompanied by a growing awareness of the problems associated with the preparation, production, and storage of the massive quantities of printed materials required by most of these systems. Many of these problems could be alleviated through the use of microfiche. Computer-generated microfiche promises substantial reductions in preparation, editing, and revision costs, and microfiche materials are cheaper to reproduce and easier to store than their printed counterparts.

In situations where there are serious limitations on storage space (e.g., aboard ship), the advantage of microfiche might assume an overriding importance. In situations where space limitations are less stringent, its advantages might be offset by relatively small variations in other factors. If, for example, students required 5 percent more time to learn from microfiche materials than from printed materials, the cost of this additional time might be more than enough to offset the savings provided. Precise trade-offs of this kind require quantitative comparisons between the two types of instructional materials.

Purpose

The purpose of the present study was to compare the performance of students using microfiche materials with that of students using printed materials in a moderately long, individualized training sequence.

Background

One form of computer-assisted instruction (CAI), the Lincoln Training System (Goodman, Brown, Frick, Harris, Karp, & LaFrey, 1973) uses microfiche as the primary means for presenting training materials. Others use it as a secondary means. Most CAI systems use some form of projected or electronically generated visual display, many of which may resemble microfiche in their effect on rate of learning. Experience with these systems has indicated that they can be used intensively for extended periods without seriously disruptive effects on student performance. In most of these systems, though, the presentation of visual information is inextricably confounded with the individualization of instruction. In comparisons with other forms of instruction, the large advantages of individualization may be masking small difficulties caused by the presentation medium. Such difficulties might have economic importance in situations where the medium can be readily separated from other aspects of the instructional system.

Precise evaluations of the effects of microfiche materials on student performance are rare. Baldwin and Bailey (1971) compared microfiche and hardcopy as sources of information for a variety of relatively short tasks. They found reliable differences favoring hardcopy on several of the tasks,

but not on three narrative reading tasks, which most closely approximate normal study behavior. This study was replicated with fairly similar results by Grausnick and Kottenstette (1971). This time, however, there were some indications of difficulty with the microfiche materials on the narrative tasks. Low-aptitude students did better with hardcopy than with microfiche on two of the three tasks. The overall differences were not reliable, but hardcopy enjoyed an average advantage of almost 9 percent. The longest of the tasks investigated required only 50 minutes, and the battery as a whole, with breaks, lasted only 4 hours. Thus, it is possible that certain effects emerge following prolonged exposure, or that some of the effects found in these studies might disappear.

Grausnick, West, and Kottenstette (1971) evaluated the use of microfiche materials in a moderately long (1 week) training sequence. Conventional lectures provided the primary means of classroom instruction. Microfiche materials were used in conjunction with these lectures to provide outlines, illustrations, and problems, and for the training manual and workbook that were used for study outside the classroom. The students worked with these materials for an average of about 3.5 hours a day. There were no reliable differences in performance between students using microfiche and students using printed materials. It should be noted, however, that this particular use of microfiche differed in several respects from its use in more individualized forms of instruction.

METHOD

Courses

Two short courses at the Naval Air Technical Training Center, Memphis, were selected for use in the study: (1) the Aviation Familiarization Course, Class P (AFAM), which covered general topics relevant to Navy aviation, and (2) the Aviation Mechanical Fundamentals Course, Class P (AMFU), which covered topics relevant to a variety of maintenance tasks.

Both courses were taught by means of individualized instruction, so the only modifications required for the study were in the medium used for instructional materials and tests. The courses consisted of modules, each of which covered a set of related training objectives. These modules are listed in Appendix A. All modules, except the two shop modules in the AMFU course, were normally taught by means of programmed booklets.

When a student completed a module, he was given an exhaustive, criterion-referenced test. These tests were subdivided into groups of related items, with each group having its own criterion for mastery. When the student failed to demonstrate mastery on one group, he was expected to review the relevant instructional material and to take a new test that was parallel to the original group of items. This process continued until he demonstrated mastery. The same procedure was used with an exhaustive, criterion-referenced final examination assigned at the end of each course. The proportion of time devoted to testing varied widely from student to student, but, on the average, accounted for a little over a quarter of the time spent in either course.

Students

The students were selected randomly from the pool of Navy students scheduled to take both the AFAM and AMFU courses.

Classroom

The instruction took place in a 60-man learning center that was normally used for these two courses. The carrels on one side of the room were used by the experimental students; and those on the other side, by the control students. The instructors were seated at one end of the room so that they could work with students from both groups. A new student was assigned to each carrel as soon as it became vacant. When a student finished the AFAM course, he started immediately on the AMFU course without changing carrels.

Materials

Printed materials were bound in several loose-leaf binders that were kept on a shelf in each carrel. Separate binders were used for instructional materials and tests.

The microfiche were black-on-white, filmed at a 20:1 reduction ratio. Each microfiche card could contain 98 frames, arranged in a 7 x 14 matrix.

Each frame provided a photograph of a page from one of the printed booklets, an identification code consisting of a number (row) and letter (column) indicating the frame's location on the card, and, in most cases, a note indicating the location of the next frame. Consecutive frames were arranged so that the student could read down a given column to the bottom frame, then move to the top frame in the next column. Each instructional program or test was contained on a single card to minimize card changing.

Cards were stored in transparent plastic envelopes that were hinged to a board in a way that revealed the index numbers and titles printed along the lower edges of all cards. There was one of these boards in each carrel used by the experimental groups.

The AFAM course required 11 cards for both instructional materials and tests; and the AMFU course, 20 cards.

Half of the carrels used by the experimental students contained Kodak Ektalite 120 Model (20X) viewers; and the other half, Bell and Howell Briefcase Reader Model 520-A viewers. In each case, the card was controlled horizontally by rotating a knob or roller and vertically by moving a slide. Displays provided direct indications of the number and letter coordinates of the frame being viewed.

The instructors were responsible for test scoring, evaluation, and assignment. These functions were performed in strict accordance with preprinted lesson guides, which were also used to give assignments to the students. The procedures used to indicate the location of microfiche materials are comparable to those used to indicate the location of printed materials. Examples of these guides are presented in Appendix B.

Design

The study consisted of two phases, each of which provided data for both courses. In both phases the control group used the printed instructional materials and printed tests normally used by students in these courses. The experimental group in Phase I also used the printed instructional materials, but they used microfiche for the tests. The experimental group in Phase II used microfiche for both the instructional materials and the tests.

Procedures

The two phases were conducted successively. Phase I was begun by substituting microfiche cards for printed tests in the 30 carrels to be used by the experimental group. Data collection started with the first student who entered the learning center after this substitution and continued until 50 students, taken in the order in which they started training, had completed both courses using microfiche test materials and an additional 50 students had completed both courses using printed materials.

After Phase I was completed, Phase II was begun by substituting microfiche cards for printed instructional materials in the carrels used by the experimental group, leaving only microfiche materials. Data collection

started with the first student who entered the learning center after this substitution and continued until 50 students had completed both courses using microfiche materials for tests and instruction and an additional 50 students had completed both courses using printed materials.

Criteria

Drops

Students are dropped from training for either academic (e.g., lack of aptitude or lack of motivation) or nonacademic (e.g., medical or disciplinary problems) causes. Nonacademic drops were excluded from all analyses. This variable is the ratio of academic drops to successful completions. The remaining criteria were derived from students who completed both courses.

Time

This variable is total training time required for course completion, excluding the time required for orientation and time required for the attitude questionnaire.

Errors

This variable is the percentage of errors made by the student on the initial administration of the final examination. The final examination for the AFAM course contained 220 items; and the final examination for the AMFU course, 336 items.

Attitude I

When the student completed the AMFU course, he was given a 15-item questionnaire to evaluate his attitude toward the course (see Appendix D). The items were in a 5-point Likert format, with 1 indicating a very unfavorable attitude, 3 a neutral attitude, and 5 a very favorable attitude. This variable is the sum of these responses.

Attitude II

Students in the experimental groups were given an additional 8-item questionnaire concerning their attitudes toward microfiche (see Appendix E). Responses to each question were analyzed separately.

RESULTS

Aptitude

The effects of using microfiche on time, errors, and Attitude I were tested by a series of treatment-by-level analyses of variance (ANOVAs). The level variable was derived from a sum of scores on the General Classification Test, the Arithmetic Test, the Mechanical Test, and the Clerical Test (all from the Navy Basic Test Battery). All students in each phase were ordered on this sum and divided into high-, medium-, and low-aptitude groups of approximately equal size. The minor variations in cell size that resulted from crossing this variable with the treatment variables were handled through the use of unweighted means. The effects of aptitude were reliable in each of the analyses involving time or errors. (In this study the term reliable indicates a $p < .05$.) There was also a tendency for Attitude I to become more favorable with increases in aptitude, but this was reliable only in Phase I. There was one reliable interaction between aptitude and medium of presentation (microfiche or printed material); this will be discussed in conjunction with the specific criterion involved, AMFU errors.

Viewers

The effects of the two kinds of viewers on time, errors, and Attitude I were compared by preliminary treatment-by-level ANOVAs of the same type used to compare the effects of microfiche and printed materials. As before, the three aptitude categories--high, medium, and low--provided the level variable. There were no reliable differences between the two viewers, but there were two reliable interactions between aptitude and the viewers. These will be discussed in conjunction with the specific criteria involved.

Phase I (Tests Only)

The means for various criteria, other than drops, are reported in Table 1.

Drops

There were four drops from the microfiche group and eight drops from the control group. The difference is far from reliable ($\chi^2 = .62$; $p > .10$), but the elimination of more marginal students from the control group may have led to a slight positive bias in the remaining sample.

AFAM Time

Students in the microfiche group required 18 percent more time to complete the course than did students in the control group ($F(1,95) = 9.14$, $p < .01$). The time actually spent with the microfiche materials was not recorded separately, so there is no direct means for determining how the extra time was distributed between the tests and other portions of the course that may have been influenced by test performance, for example, remedial assignments.

Table 1

Performance of Microfiche and Control Students
Phase I

Item	Training Method	
	Microfiche (N = 51)	Control (N = 50)
AFAM Time (hr.)*	11.8	10.0
AFAM Errors (%)	4.1	3.7
AMFU Time (hr.)	49.9	45.1
AMFU Errors (%)	7.1	7.0
Attitude I	56.7	56.0

*$p < .05$

AFAM Errors

The difference between the experimental and control groups on the AFAM final examination was small and unreliable. If all or part of the differences in training time were due to a difference in the number of remedial assignments, then one would have to assume a corresponding difference in the number of errors made on tests, since it is errors that lead to remedial assignments. These data suggest that if there were such a tendency, it must somehow have been limited to the end-of-module tests.

AMFU Time

The microfiche group required 11 percent more training time than did the control group, but this difference was not reliable. The actual size of the difference, relative to total training time, was considerably less than that found for the AFAM course.

AMFU Errors

The overall difference between the two groups on the AMFU final examination was small and unreliable. However, there were reliable interactions between the experimental treatments and aptitude and between the two microfiche viewers and aptitude. (Cell means for all ANOVAs yielding significant interactions are presented in Appendix C.) Both interactions seem to stem from a high concentration of errors in the middle aptitude range of students using the Bell and Howell viewers. There is no obvious reason for such a concentration, nor were similar effects found in the remaining analyses.

Attitude I

Both the experimental and control groups had favorable attitudes toward the courses. The difference between the two was small and unreliable. Student responses to individual questions are summarized in Appendix D.

Attitude II

Responses by the experimental students to the eight questions pertaining to microfiche utilization are shown in Appendix E. Differences between the two viewers were tested by means of χ^2 and none was found to be reliable. The responses were fairly positive and there was little indication of real problems with the materials. Product moment correlations were computed between these responses and training times in hopes that these relationships would aid in the identification of factors that affected training time in the experimental group. These correlations can be found in Appendix F. Most of the coefficients were negative, as might be expected, and low. Only 1 of the 16 was reliable. The relationships between the responses and time in the AFAM course, where microfiche had a reliable effect on performance, were much the same as the corresponding relationships in the AMFU course, where microfiche did not have a reliable effect on performance.

Phase II (All Materials)

The means for various criteria other than drops are reported in Table 2.

Table 2

Performance of Microfiche and Control Students
Phase II

Item	Training Method	
	Microfiche (N = 50)	Control (N = 56)
AFAM Time (hr.)*	12.5	9.9
AFAM Errors (%)	4.0	4.8
AMFU Time (hr.)	45.1	40.9
AMFU Errors (%)	6.3	7.8
Attitude I	56.5	55.9

*$p < .05$

Drops

There were six drops from the microfiche group and one drop from the control group. The difference was not reliable ($p > .10$, Fisher exact probability). Any biasing effect of this difference on the remaining sample would be opposite to that in Phase I.

AFAM Time

Students in the microfiche group required 26 percent more time to complete the course than did students in the control group ($F(1,101) = 13.95$, $p < .01$). The difference is larger than that found in Phase I, but the increase in training time is not proportionate to the increase in the amount of microfiche materials.

AFAM Errors

The difference between the two groups on the AFAM final examination was small and unreliable.

AMFU Time

The microfiche group required 10 percent more time to complete the course than did the control group, but the difference was not reliable. There was a reliable interaction between aptitude levels and type of microfiche viewer. The cell means indicate that low-aptitude students were unusually fast when using the Bell and Howell viewer, but this pattern does not appear in any of the other three analyses of training time.

AMFU Errors

The difference between the two groups on the AMFU final examination was small and unreliable.

Attitude I

Both experimental and control groups had favorable attitudes toward the courses. The difference between the two was small and unreliable. Student responses to individual questions are summarized in Appendix D.

Attitude II

Responses to these questions were similar to those found in Phase I. There were no reliable differences between viewers, no indications of serious problems with the materials (see Appendix E), and the correlations with training time were small, negative, and unreliable (see Appendix F).

The differences between the responses of the experimental groups in the two phases were tested by means of χ^2. The only reliable difference was on Question 7. The students in Phase I, who spent about 3 hours a day using the microfiche materials, felt that the average student could spend about 5 hours a day with such materials without adverse effects. The students in Phase II, who spent about 7 hours a day using the microfiche materials, felt that the average student could spend about 6 hours a day with such materials without adverse effects.

DISCUSSION

Differences in Training Time

The use of microfiche materials in these studies led to longer training times. The differences in the AFAM course were reliable in both phases. The differences in the AMFU course were not reliable, but in each of the two independent comparisons the probability of no difference was fairly small ($p = .07$). There are various opinions concerning the way in which marginal probabilities of this kind should be interpreted, but most statisticians would probably agree that they provide at least some additional support for the assumption that students do not progress as rapidly using microfiche materials as they do using printed materials.

Reasons for the Differences

Confidence in this assumption would be reinforced by clear indications of the mechanisms responsible for the differences, but unfortunately the data do not provide such indications. The more obvious of the potential mechanisms can be sorted into two general categories. The first consists of difficulties the student might experience in extracting information from the microfiche materials once he has found and displayed the proper materials. The second consists of difficulties the student might experience in locating and displaying proper materials. Each of these categories will be discussed in some detail, followed by a brief consideration of some less direct possibilities.

Difficulties in Extracting Information

Any stable difficulties associated with the extraction of information from microfiche materials should have created differences in the times required by experimental and control groups that are roughly proportionate to the amount of microfiche material used by the experimental group. There was roughly four times as much microfiche material in the AMFU course as in the AFAM course, and roughly four times as much in Phase II as in Phase I. The treatment means have sizable standard errors, so it would be a mistake to put too much faith in the pattern of obtained differences. Nevertheless, the pattern is not particularly consistent with the hypothesis of proportionate differences. Time differences in the AMFU course are only about twice as large as those in the AFAM course, and time differences in Phase II were only slightly larger than those in Phase I.

It was originally felt that certain difficulties, for example, fatigue or eye strain, might increase with prolonged, intensive use of microfiche materials. If increasing difficulties of this kind were added to the stable difficulties discussed above, it would actually increase the discrepancies between the pattern of predicted differences and the obtained results. In fact, the results suggest that if the differences are due entirely to difficulties associated with the extraction of information from microfiche materials, then these difficulties must <u>decrease</u> fairly rapidly following an initial exposure. Such adaptation or habituation might explain both the diminished impact found when microfiche

instructional materials were added to microfiche test materials in Phase II (even within the relatively short AFAM course) and the diminished impact found when students reached the second course.

Several items from the Attitude II questionnaire pertain to difficulties that the student might experience in extracting information from the microfiche materials. If any of these difficulties had a dominant influence on performance, then it might be expected (1) that a substantial number of students would indicate that they had experienced the difficulty, and (2) that the students who had experienced the difficulty would perform more poorly than those who had not.

It might also be expected that the relationships with performance would be stronger in the AFAM course, where the difficulties seem to have had the greater impact. The questionnaire, however, which was designed to measure student reaction to the entire sequence, may actually have been more indicative of the student's feelings during the AMFU course, which was longer and more recent, than during the AFAM course.

Felt Tired (Question 1). Roughly 38 percent of the students who used microfiche indicated that they frequently or almost always felt tired at the end of the training day, but 27 percent of the control students expressed similar feelings. The correlations between these feelings and training time were small and variable (see Appendix F).

Read Slowly (Question 4). Roughly 28 percent of the students who used microfiche felt that they read more slowly than usual, but almost as many felt that they read more rapidly than usual. The correlation with training time in the AFAM course during Phase I (-.30) was marginally reliable. The remaining correlations, though smaller, were fairly consistent. There was a slight tendency toward stronger correlations in the AFAM course.

More Mistakes (Question 5). Roughly 27 percent of the students who used microfiche felt that they would make more mistakes than usual, but a slightly higher percentage felt that they would make fewer mistakes than usual. The correlations with training time were small and variable.

Bothered Eyes (Question 6). Roughly 24 percent of the students felt that the microfiche materials bothered their eyes to the point that it was disturbing. The correlation with training time in the AMFU course during Phase II (-.36) was marginally reliable, but only after the effect of aptitude had been partialled out. The remaining correlations were smaller but fairly consistent.

Difficulties in Locating Materials

Locating the proper microfiche materials consists of several fairly distinct activities: locating the proper card, locating the proper initial frame, and, when the lesson or test requires more than a single frame, locating successive frames on a given card. It seems likely that the first two activities would be more time-consuming and more subject to errors than the last activity.

Difficulties in accessing the initial frame of a lesson or test should have created differences in the times required by experimental and control groups that are roughly proportionate to the number of accesses required by the experimental group. Barring accesses associated with remedial assignments, there were roughly half again as many accesses required in the AMFU course as in the AFAM course, and twice as many accesses required in Phase II as in Phase I. The actual differences in training time are closer to this pattern than they are to the pattern based on difficulties in extracting information. The obtained differences between the two courses were actually somewhat larger than those predicted. The differences between phases, however, were smaller.

Two items from the questionnaire bear directly on difficulties of this kind.

Trouble Finding Card (Question 2). Roughly 80 percent of the students indicated that they never had trouble finding the right card. The remaining students had trouble only once or twice. Correlations with training time were low and variable.

Trouble Finding Page (Question 3). Roughly 74 percent of the students indicated that they never had trouble finding the right page/frame. Most of the remaining students had trouble only once or twice, although one student indicated that he had trouble several times, and another indicated that he had trouble frequently. Correlations with training time were again low and variable.

Even if every one of the difficulties reported on these questions had led to an extra remedial assignment, their influence would not have been enough to account for all the differences in training time. A study by Keeler and Rizzo (1976) deals specifically with difficulties in locating microfiche materials and, in fact, one of the viewers used in their study was also used in the present studies. They found that about 43 seconds were required to locate a card, insert it in the viewer, and position it to the initial frame. Roughly 10 seconds were required to shift from frame to frame on the same card, even when successive frames were randomly ordered on the card. Mistakes were made on only 5 percent of the attempted frame locations. Times (and errors) of this magnitude can explain no more than a fraction of the differences found in the present study.

Other Factors

The preceding discussion does not provide compelling support for any single difficulty as an explanation for the results found in this study, but neither does it preclude an explanation based on some combination of these difficulties. If several factors are involved, then perhaps moderate complaints and low correlations should be expected.

It is more difficult to use these same factors as explanations for the differences between the results of the present study and those of the earlier studies (Baldwin & Bailey, 1971; Grousnick & Kottenstette, 1971). Testing time in the AFAM course, at least for the control group,

is only slightly greater than the average exposure to microfiche in the previous studies, and it is certainly more distributed, but the difference produced by microfiche in Phase I is considerably larger than the differences produced in the earlier studies. Part of the discrepancy may be due to difficulties in locating the materials, but, as noted previously, it is unlikely that this accounts for the whole difference.

Additional reasons for the difference may stem from differences in the instructions to the subjects or students. In all three of the previous studies, the microfiche materials were explicitly presented as part of an experiment, and considerable emphasis was placed on both the speed and accuracy of performance. In the present study the microfiche materials were introduced as a routine technique for the presentation of instructional materials, and there was relatively little emphasis on time. An effort was made to avoid anything that would suggest to the students that they were special in any way.

The emphasis on the experimental nature of the earlier studies may have been sufficient to elicit the extra effort required to compensate for minor difficulties with the material. The lack of emphasis on time in the present study may have had a more subtle effect. If the students were at all anxious about their ability to use the microfiche materials without error, then they would face the problem of trying to maximize both speed and accuracy. The conflict between the two would probably be felt most acutely with the test materials. If the conditions created in this study inclined the students toward a greater concern with accuracy, then the students might well have proceeded with greater caution and deliberation. The time lost through such deliberation might not have been reported as a loss in reading speed.

Adaptation

It has been suggested that some of the difficulties encountered during the first few hours of exposure to microfiche may lose some of their effect with continued exposure. The term "adaptation" has been used to describe this loss, though all or part of it could be due to things like practice or a reduced fear of errors. If adaptation does occur, its magnitude and course over time would have a major influence on the economics of microfiche use. If, for example, all differences in treatment means stem from difficulties that are subject to adaptation, and if this adaptation has completely eliminated all difficulties by the end of the second course, then the overall effect of microfiche use in an extended training sequence would be quite small. If, on the other hand, the differences in treatment means stem from difficulties that are not subject to adaptation, or if whatever adaptation does occur has run its course by the end of the first course, then the long-term effects of microfiche use would be appreciable. Unfortunately, the data provided by this study, even if perfectly accurate, would be inadequate to distinguish between even these extreme alternatives.

CONCLUSIONS

The clear differences found in the short AFAM course are important primarily as indicators that there is something about microfiche that can retard student progress. The economic consequences of this effect are dependent on the extent to which it endures through continued exposure, but the evidence for this endurance is equivocal. One difficulty is that this study was simply not powerful enough to ensure that differences large enough to be practically significant would also be statistically significant. Another difficulty is that performance was measured only at the completion of the two courses, and this was insufficient to provide a clear picture of any changes in the effect of microfiche that might have been taking place.

Regardless of these unresolved questions, the differences found in this study warrant serious concern. Differences the size of those found in Phase I would have increased the cost of student salaries in this rather short training sequence by about $300,000 per year. Microfiche materials are presently being used for tests in the Basic Electricity and Electronics course, where the average student load is about eight times that of the sequence investigated in these studies. If these materials are creating differences that approach those found in Phase I, their yearly cost is impressive.

There is an obvious need for more precise estimates of these effects. However, the degree of precision and control required for such estimates would be difficult to achieve in the laboratory, and still more difficult to achieve in a realistic training environment.

RECOMMENDATIONS

Before commitments are made to an extensive use of microfiche materials, it would be advisable to evaluate their long-term effects in a study with sufficient power to assure potential users that real differences approaching the differences found in this study do not exist.

REFERENCES

Baldwin, T. S., & Bailey, L. J. Readability of technical training materials presented on microfiche vs. offset copy. Journal of Applied Psychology, 1971, 55, 37-41.

Goodwin, L. M., Brown, J. R., Frick, F. C., Harris, W. P., Karp, D., & LaFrey, R. R. The Lincoln Training System. IEEE Transactions on Communications, 1973, Com-21, 1335-1345.

Grausnick, R., & Kottenstette, J. P. A performance evaluation: Microfiche vs. hardcopy (AFHRL-TR-71-42). Lowry Air Force Base, CO: Air Force Human Resources Laboratory, May 1971. (AD-734 740)

Grausnick, R., West, A., & Kottenstette, J. P. Microform use in a technical training environment - an experiment (AFHRL-TR-71-43). Lowry Air Force Base, CO: Air Force Human Resources Laboratory, May 1971. (AD-733 686)

Keeler, F. L., & Rizzo, W. A. An evaluation of microfiche reader types for use with programmed instruction (TAEG Report No. 35). Orlando, FL: Training Analysis and Evaluation Group, August 1976. (AD-A029 714)

APPENDIX A

CONTENT OF AFAM AND AMFU COURSES

CONTENT OF AFAM AND AMFU COURSES

AFAM Modules

1. Military Aircraft Designation Systems
2. Basic Theory of Flight and Aircraft Nomenclature
3. Aircraft Handling Crews, Securing Devices, and Safety in Line Operations
4. Aviation Support Equipment
5. Naval Aviation Rating Familiarization
6. Aircraft Carriers
7. Aircraft Firefighting
8. Naval Aviation Organization
9. Student Aircraft Taxi Signals
10. Basic Aircraft Systems
11. Aircraft Cleaning
12. Aviation Fuels, Oils, and Hydraulic Fluids

AMFU Modules

1. Naval Aviation Maintenance Program
2. Work Unit Code Manual
3. Maintenance Requirement Cards
4. Corrosion
5. Mechanics of Heat and Gases, Static Electricity, and Basic Hydraulics
6. Addition, Subtraction, Multiplication, and Division of Fractions
7. Addition, Subtraction, Multiplication, and Division of Decimals
8. Support Action Form
9. Single-Copy Maintenance Action Form
10. Aircraft Hardware

11. Wrenches

12. Screwdrivers and Pliers

13. Measuring and Marking Tools and Drills

14. Vises, Files, and Hacksaws

15. Punches, Chisels, and Striking Tools

16. Maintenance and Operation Manuals

17. Multi-Copy Maintenance Action Form

18. Torque Wrenches

19. Shop I

20. Shop II

APPENDIX B

AFAM STUDENT LEARNING GUIDES

AFAM STUDENT LEARNING GUIDES

Learning Guide for Control Groups

Course #017 Carrel # _____

You are now reading your first Learning Guide. The Learning Guides you receive will direct you through the "Aviation Familiarization" Course.

Your first assignment is:
Program: Computer Managed Instruction - Student Briefing.
Test: PT-1 Practice test exercise located in the "Student Briefing" booklet.

Be sure to turn in your practice test answer sheet to the instructor. Then begin the assignments listed below.

All instructional programs will be found, in sequence, in the black AFAM Programs Volume.

All tests will be found in the green AFAM Tests volumes.

Group One

Program: Military Aircraft Designation System.
Test: ADS-1 Page 28 Volume 1 CMI 15 (H)

Program: Basic Theory of Flight and Aircraft Nomenclature.
Test: TFN-2 Page 105 Volume 1 CMI 13 (M)

Program: Aircraft Handling Crews, Securing Devices, and Safety in Line Operations
Test: AHC-2 Page 117 Volume 1 CMI 14 (M)

Program: Aviation Support Equipment.
Test: ASE-2 Page 133 Volume 1 CMI 6 (H)

Program: Naval Aviation Rating Familiarization.
Test: ARF-2 Page 80 Volume 1 CMI 7 (F)

END OF GROUP ONE - REPORT TO INSTRUCTOR

Learning Guide for Microfiche Group

Phase II

Course #017 Carrel # _____

You are now reading your first Learning Guide. The Learning Guide you receive will direct you through the "Aviation Familiarization" Course.

Your first assignment is:
Program: Computer Managed Instruction - Student Briefing.
Test: PT-1 practice test exercise located in the "Student Briefing" booklet.

Be sure to turn in your practice test answer sheet to the instructor. Then begin the assignments listed below.

All instructional materials and tests will be found on the set of microfiche cards located in your carrel.

EXAMPLE: Program: Aviation Fuels and Oils 003 (J-1)
Card number

Frame location

You will find the card number on the yellow strip at the top of each card. Insert card 003 in your microfiche reader according to the instructions given by your Learning Center Supervisor and move to the reference frame J-1 using the edge references on the reader. You will continue on the frame J-2, J-3, etc.

Group One

Program: Military Aircraft Designation System. 001(A-1)
Test: ADS-2 Card 101 (A-5) CMI 14 (L)

Program: Basic Theory of Flight and Aircraft Nomenclature 001(D)
Test: TFN-1 Card 100 (E-4) CMI 12 (H)

Program: Aircraft Handling Crews, Securing Devices, and Safety in Line Operations 001(F-1)
Test: AHC-1 Card 100 (G-3) CMI 13 (F)

Program: Aviation Support Equipment 001(I-1)
Test: ASE-1 Card 100 (I-5) CMI 5 (M)

Program:	Naval Aviation Rating Familiarization	002(A-1)
Test:	ARF-1 Card 100 (B-2) CMI 8 (P)	

END OF GROUP ONE - REPORT TO INSTRUCTOR

APPENDIX C

CELL MEANS FOR INTERACTIONS

CELL MEANS FOR INTERACTIONS

Table C-1

Errors on AMFU Final Examination, Phase 1,
Microfiche and Control

	Training Method	
Aptitude	Microfiche	Control
High	13.611	19.235
Medium	29.125	18.824
Low	29.118	32.562

Table C-2

Errors on AMFU Final Examination, Phase I,
Bell and Howell and Kodak

	Projector	
Aptitude	Bell and Howell	Kodak
High	14.571	11.600
Medium	35.000	25.000
Low	26.636	37.500

Table C-3

AMFU Time (Hr.), Phase II, Bell and Howell and Kodak

Aptitude	Projector	
	Bell and Howell	Kodak
High	39.889	33.250
Medium	50.400	45.100
Low	46.364	60.143

APPENDIX D

ATTITUDE I QUESTIONNAIRE AND RESULTS

ATTITUDE I QUESTIONNAIRE AND RESULTS

Questions 1 through 15 were common to both microfiche and control students in Phase I and Phase II. The last alternative for each item indicates a favorable attitude.

Table D-1

Attitude I Questionnaire

Item	Percentage of Responses			
	Phase I		Phase II	
	Microfiche	Control	Microfiche	Control
1. I felt challenged to do my best work.				
a. Strongly disagree	4	0	0	2
b. Disagree	2	6	6	5
c. Uncertain	8	6	2	4
d. Agree	76	60	58	61
e. Strongly agree	10	28	33	28
2. I was concerned that I might not be understanding the material.				
a. Strongly agree	12	8	4	8
b. Agree	18	38	42	38
c. Uncertain	20	18	17	23
d. Disagree	42	34	33	28
e. Strongly disagree	8	2	4	2
3. I felt myself just trying to get through the courses rather than trying to learn.				
a. All the time	0	0	4	2
b. Most of the time	4	8	0	4
c. Some of the time	24	32	27	28
d. Only occasionally	30	32	42	30
e. Never	28	42	27	37
4. I tried to learn as much as I could.				
a. Never	0	0	0	0
b. Only occasionally	0	0	0	4
c. Some of the time	2	14	6	4
d. Most of the time	46	46	46	42
e. All of the time	42	40	48	51

Table D-1 (Continued)

Item	Percentage of Responses			
	Phase I		Phase II	
	Microfiche	Control	Microfiche	Control
5. The material was easy to learn.				
a. Strongly disagree	2	0	2	2
b. Disagree	12	12	17	19
c. Uncertain	14	28	25	24
d. Agree	64	54	46	53
e. Strongly agree	8	6	10	2
6. The material was difficult to remember.				
a. Strongly agree	0	0	4	5
b. Agree	24	18	12	21
c. Uncertain	32	20	19	16
d. Disagree	36	58	50	51
e. Strongly disagree	8	4	14	7
7. I felt frustrated by the way these courses were run.				
a. Strongly agree	4	8	4	9
b. Agree	6	12	10	10
c. Uncertain	8	6	12	9
d. Disagree	58	48	50	51
e. Strongly disagree	24	26	23	21
8. The material was presented effectively.				
a. Strongly disagree	0	2	2	0
b. Disagree	6	6	2	7
c. Uncertain	6	10	12	9
d. Agree	72	64	60	58
e. Strongly agree	16	18	23	26
9. I felt that too much was expected of me.				
a. Strongly agree	2	2	4	2
b. Agree	4	2	4	4
c. Uncertain	6	14	12	9
d. Disagree	64	52	46	61
e. Strongly disagree	24	30	33	24

Table D-1 (Continued)

Item	Percentage of Responses			
	Phase I		Phase II	
	Microfiche	Control	Microfiche	Control
10. The learning was too mechanical.				
a. Strongly agree	0	0	4	0
b. Agree	4	4	8	9
c. Uncertain	2	10	12	5
d. Disagree	56	60	56	55
e. Strongly disagree	38	26	19	30
11. This type of instruction made me feel quite tense.				
a. Strongly agree	6	2	2	7
b. Agree	18	22	23	23
c. Uncertain	24	14	10	14
d. Disagree	36	48	42	47
e. Strongly disagree	16	14	23	9
12. I would prefer this type of instruction over traditional instruction.				
a. Strongly disagree	10	6	10	4
b. Disagree	10	14	14	9
c. Uncertain	16	20	10	21
d. Agree	36	22	29	30
e. Strongly agree	28	38	35	37
13. I felt that I could have learned as much without taking so many tests.				
a. Strongly agree	2	2	2	4
b. Agree	6	6	8	9
c. Uncertain	12	12	10	18
d. Disagree	54	52	52	46
e. Strongly disagree	26	28	27	24
14. In view of the amount I learned, I would say this type of instruction is superior to traditional instruction.				
a. Strongly disagree	2	2	4	2
b. Disagree	14	12	6	10
c. Uncertain	24	22	14	14
d. Agree	38	40	42	53
e. Strongly agree	22	24	33	21

Table D-1 (Continued)

Item	Percentage of Responses			
	Phase I		Phase II	
	Microfiche	Control	Microfiche	Control
15. I would prefer subsequent courses to be this type of instruction rather than traditional instruction.				
a. Strongly disagree	4	2	6	7
b. Disagree	22	16	10	4
c. Uncertain	20	32	29	33
d. Agree	48	30	29	37
e. Strongly agree	6	20	25	19

APPENDIX E

ATTITUDE II QUESTIONNAIRE AND RESULTS

ATTITUDE II QUESTIONNAIRE AND RESULTS

Questions 1 through 8 were common to microfiche students in Phase I and Phase II. The last alternative for each item indicates a favorable attitude.

Table E-1

Attitude II Questionnaire

Item	Percentage of Responses	
	Phase I Microfiche	Phase II Microfiche
1. I felt tired at the end of the training day.		
a. Almost always	14	17
b. Frequently	18	27
c. Occasionally	20	27
d. Rarely	41	21
e. Almost never	7	8
2. I had trouble finding the right microfiche card.		
a. Frequently	0	0
b. Several times	0	0
c. Once or twice	23	17
d. Never	77	83
3. I had trouble finding the right page on the microfiche cards.		
a. Frequently	0	2
b. Several times	0	2
c. Once or twice	25	23
d. Never	75	72
4. With the microfiche materials, my reading speed was		
a. quite a bit slower than usual	9	8
b. slightly slower than usual	16	23
c. about the same as usual	41	49
d. slighly faster than usual	34	19

Table E-1 (Continued)

Item	Percentage of Responses	
	Phase I Microfiche	Phase II Microfiche
5. When I used microfiche instead of regular printed materials, I felt that I would make		
a. many more mistakes	4	6
b. slightly more mistakes	23	21
c. about the same number of mistakes	39	42
d. slightly fewer mistakes	34	30
6. The microfiche materials bothered my eyes		
a. very much	4	6
b. enough to be disturbing	23	15
c. slightly, but not enough to be disturbing	32	53
d. not at all	41	26
7. How much time each day could the average student spend using microfiche materials without being seriously bothered by it?		
a. None	0	0
b. 1 hour	7	0
c. 3 hours	18	2
d. 5 hours	39	42
e. 7 hours	36	55
8. In future courses, how much of the material each day would you like to have presented by means of microfiche?		
a. None	14	16
b. 1 hour	9	4
c. 3 hours	26	20
d. 5 hours	28	38
e. 7 hours	23	22

APPENDIX F

CORRELATIONS BETWEEN ATTITUDE AND TRAINING TIME

CORRELATIONS BETWEEN ATTITUDE AND TRAINING TIME

The following are product moment correlations computed between responses to items on the Attitude II questionnaire and time in training. For each item, the top row consists of zero order correlation coefficients. The bottom row consists of partial correlation coefficients with effect of aptitude removed.

Table F-1

Correlations Between Attitude and Training Time

Item		Phase I		Phase II	
		AFAM	AMFU	AFAM	AMFU
1.	I felt tired at the end of the training day.	-.14 -.05	-.17 -.07	.09 .00	.18 .07
2.	I had trouble finding the right microfiche card.	-.13 -.10	-.18 -.17	-.04 -.06	.04 .03
3.	I had trouble finding the right page on the microfiche cards.	.01 -.05	-.16 -.29	-.16 -.13	-.17 -.14
4.	With microfiche materials, my reading speed was (slower/faster).	-.30 -.33	-.14 -.16	-.23 -.20	-.14 -.09
5.	When I used microfiche instead of regular printed materials, I felt that I would make (more/fewer) mistakes.	-.07 -.19	.04 -.09	-.11 -.15	-.10 -.17
6.	The microfiche materials bothered my eyes.	-.12 -.17	-.12 -.20	-.07 -.11	-.26 -.36
7.	How much time each day could the average student spend using microfiche materials without being seriously bothered by it?	.03 -.07	-.04 -.20	.04 -.06	-.04 -.22
8.	In future courses, how much of the material each day would you like to have presented by means of microfiche?	-.17 -.24	-.12 -.21	.08 .03	.20 .15